flux

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FEATURES

ABOUT flux

Flux is a twice-yearly publication dedicated to exploring the research, magnet technology, and science outreach conducted at the National High Magnetic Field Laboratory in Florida. Want to get some extra copies for a classroom or a favorite science buff? Contact Amy Mast at winters@magnet.fsu.edu.

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REGULAR FEATURES

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The National High Magnetic Field Laboratory, or Magnet Lab, is a national user facility that provides state of the art research resources for magnet related research in all areas of science and engineering. The Magnet Lab is supported by the National Science Foundation and the State of Florida, and is operated by Florida State University, the University of Florida and Los Alamos National Laboratory.

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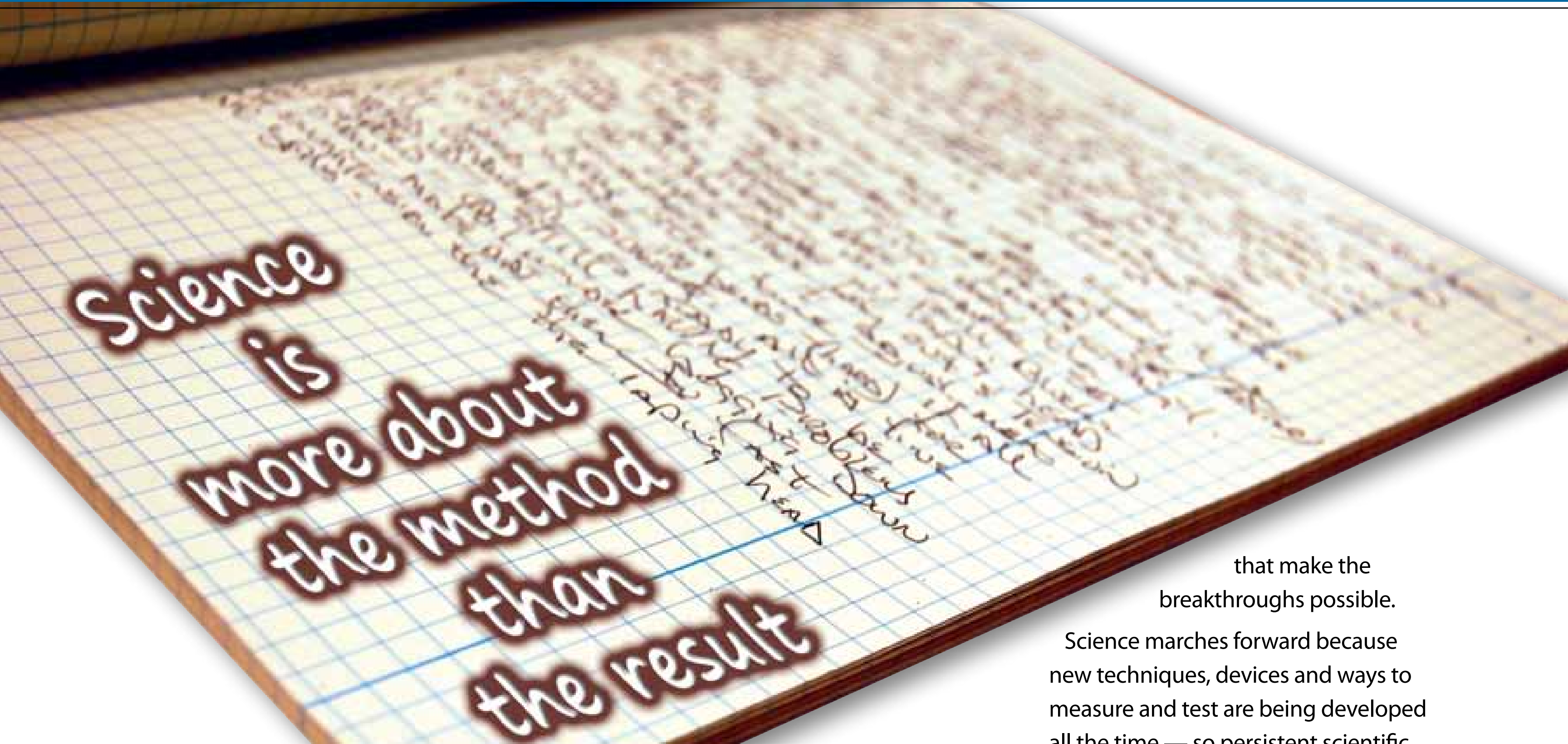


Science is more about the method than the result

Why are so many Americans distrustful of science?

Maybe it's because the health landscape is constantly changing, and most people's contact with science is limited to health news they read in the paper or see on the TV news. And because health is the one thing that personally affects us all, people tend to pay attention.

It does get confusing. Hormone replacement therapy is a classic example. For years, menopausal women took HRT to alleviate the symptoms of menopause. Research later showed a higher incidence of breast cancer in HRT patients … but other research showed that HRT reduced the risk of heart disease in women. And *now*, it's generally accepted that the risks of HRT outweigh the benefits. No wonder people are skeptical.

Although most people would like findings to be definitive, science seldom deals in absolutes. It is based on the preponderance of scientific evidence available **at that time**. The pace of progress in science is slow and incremental. This may surprise people, because it's only the breakthroughs that are covered in the media (although where science is concerned, less and less everyday). You don't hear about the years and sometimes decades of work that make the breakthroughs possible.

Science marches forward because new techniques, devices and ways to measure and test are being developed all the time — so persistent scientific mysteries and old problems can be looked at in entirely new ways. That's how something that was considered valid 20 years ago might not be considered valid today.

"A useful analogy is to compare the telescope that Galileo used centuries ago and the Hubble space telescope used by astronomers today," said Tim Murphy, a low-temperature physicist at the lab. "If you look at it from a broad perspective, both Galileo and the modern astronomical community are investigating the same thing (the known universe) but the tools and methods have advanced so much that new discoveries are happening all the time even though they are looking at the same sky that Galileo viewed through his telescope hundreds of years ago."

So it's not surprising to see a material that was first studied in the 1960s being studied again today at the Mag Lab.

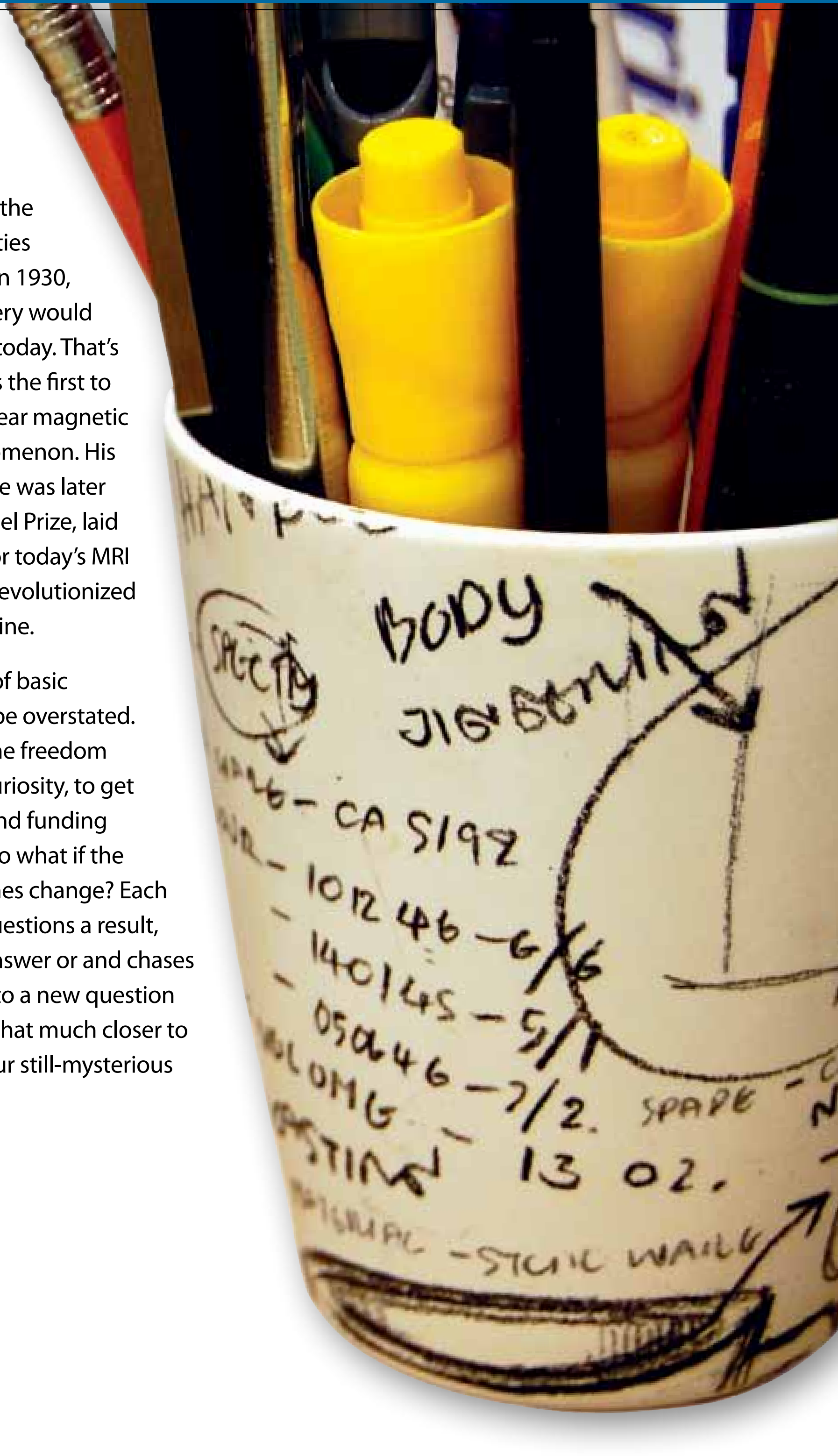
It helps to understand the scientific method, which isn't exactly like most people think it is. You may be surprised to hear much of the research at the Mag Lab does not begin with a hypothesis. It's not so much, "I think this will happen when I put this material in the magnet," but more like, "I wonder what will happen when I put this material in the magnet." (That said, they don't just plunk a sample into a high magnetic field and hope some exciting behavior arises; the study is directed and not frivolous).

So what does the research begin with? Asking a question (even if it's "I wonder what will happen if… ?"). Scientists then try to answer the question by designing experiments. They observe, collect and analyze data, which may then lead to some sort of hypothesis. And of course, the steps and outcomes must be repeatable, so that anyone doing the same experiment would get the same results.

The "I wonder what…" approach to science explains why scientists around here sometimes refer to their work as "curiosity-based" science. Although we in the communications side of the lab often wince when they say that (because taxpayers, who make the research possible, might not appreciate paying the salaries of people who are curious for a living) — this approach is vitally important to maintaining our nation's standard of living.

If American physicist Isidore Rabi hadn't wondered about the magnetic properties of atomic nuclei in 1930, exploratory surgery would still be the norm today. That's because Rabi was the first to discover the nuclear magnetic resonance phenomenon. His work, for which he was later awarded the Nobel Prize, laid the foundation for today's MRI scanners, which revolutionized diagnostic medicine.

The importance of basic research cannot be overstated. Scientists need the freedom to pursue their curiosity, to get the time, space and funding to ask "what if?" So what if the answers sometimes change? Each time someone questions a result, reinterprets an answer or and chases after the answer to a new question in earnest, we're that much closer to understanding our still-mysterious world.



The view from Cell 7: the life of a magnet experiment

BY AMY MAST

A scientist has an idea, does an experiment, gets a result, and writes a paper about it. Simple, right? Yes—and no. If you've ever hung out with a little kid who asks "why" over and over and over for every answer you give, it's more like that. From the time a scientist finds a question he or she wants to ask, to the time the answer to that question is publishable as a paper, several people, states and countries can be involved, and each question only leads to asking more.

As the director of DC user programs and as a researcher himself, Eric Palm knows a thing or two about the process of planning, guiding and publishing an experiment. Rather than a straight line from start to finish, he describes the process of gathering data as circular.

"With any halfway decent experiment, you end up with more questions than you answer, and that's the cool thing about science," said Palm. "Science isn't about determining actual truth — it's about getting to our best understanding of the world we live in. We can get to a better and better understanding, but each new level kind of brilliantly reveals all these things we still don't know," Palm explained.

Users who come to the Magnet Lab are in the experimental, data-gathering phase of this process. Stuart Brown of UCLA is a longtime user who makes his living learning about how matter behaves at very low temperatures. He visited the lab this fall, using a resistive magnet to discover more about the properties of a superconductor he finds exciting.

If they were on a soap opera together, superconductors and magnets would have a stormy relationship. Magnetism has a nasty tendency to kill superconductivity, and Brown's at the lab to study a superconductor that performs better than usual in a high magnetic field.

For his experiment, Brown is using the magnet in cell 7, set to a magnetic field between 15 and 30 tesla. This magnet is ideal for experiments when a user needs to be able to note all the subtleties of his or her data.

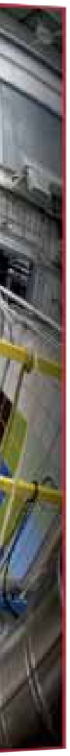
The view from the magnet platform in cell 7. In the foreground, Magnet Lab physicist Phil Kuhns begins a liquid nitrogen transfer; below is the floor of the cell, where Brown is sitting. *Photo by Larry Gordon*

For Brown and many other Magnet Lab users, a typical magnet experiment involves:

1. *Asking a question.*
2. *Deciding which tools will be best to get an answer.*
3. *Requesting magnet time and scheduling a trip to the Magnet Lab.*
4. *Working with his own team, plus magnet lab support staff, to gather experimental data.*
5. *Going home with the data and figuring out what it means.*
6. *Assembling the data into a paper that states the original question, describes the experimental process and includes figures to visually demonstrate the data's significance.*
7. *Submitting the completed paper for publication.*
8. *Making any changes reviewers suggest.*
9. *Celebrating!*

About 1,000 users such as Brown gather data at one of the lab's seven user programs each year. All prospective users apply for magnet time, then wait to see if they're one of the 25 percent to 50 percent whose applications are accepted. Because magnet science is a comparatively small field, most users have been here before (though about 1 in 5 resistive magnet users during the past year were making their first trip).

"With the type of experiments that I do, from start to finish it can take a couple of years before I'm ready to share some data," Brown explained. "You can conjecture at first but you don't know what's going to happen when your sample goes into the magnet, and you have to have the patience to see where it takes you. There are always unanticipated circumstances, because you're not measuring where someone has been before."



Stuart Brown, a user with a home lab at UCLA, examines paperwork during his magnet time in cell 7. *Photo by Larry Gordon*

MAG LAB MACGYVERS

BY SUSAN RAY

When you think of scientists at work, do you conjure up images of lab coats? Clean rooms? Microscopes, beakers, test tubes and Bunsen burners?

Well, if that's the case, you better clear your brain's cache, because here at the Mag Lab, inside our magnet "cells" and beyond — science is messy, often unpredictable and very creative. Yes, creative.

This is the realm of experimental physicists. Their job is to make observations and gather data about different physical phenomena, whereas theoretical physicists focus on predicting or explaining physical phenomena.

In experimental physics, getting the data is job 1, and it's why scientists travel hundreds and even thousands of miles to the Mag Lab for just one week of magnet time.

Magnet time is like the day before a final exam in terms of pressure. Scientists come in early and stay late, subsisting on a steady diet of convenience foods and caffeine. Much is at stake (beyond the travel expense): Graduate students who accompany the scientists may need the data to complete their Ph.D. thesis. Publications, the lifeblood of basic research, hang in the balance. So when things go wrong or threaten to interfere with an experiment, as they often do,

Mag Lab MacGyvers (user support scientists) stand at the ready.

For the uninitiated, MacGyver was a staple of mid-1980s prime-time television. The title character used practical application of scientific know-how and clever use of common household items—in particular a Swiss Army knife—to beat the bad guys.

While Mag Lab MacGyvers aren't dealing with life and death, they are dealing with stressed and often jet-lagged scientists, who have traveled many miles for magnet time. So when the going gets rough, they spring into action armed with only their wits — and tape.

Tape: A science staple

A layer of graphite one atom thick holds great promise for the future of microelectronics. It's called graphene — but how exactly does a person slice one atom's thickness off what is essentially a pencil trace?

Paul Cadden-Zimansky, a Columbia University-Magnet Lab postdoctoral fellow who studies graphene, said scientists tried several different methods to get very thin pieces of graphite. A group at Cornell University put pieces of graphite in a liquid solution, then subjected the liquid to sonic vibrations to break up the graphite into thinner sheets.

Cadden-Zimansky's boss at Columbia, Philip Kim, tried to attach graphite to a microscopic cantilever; the cantilever functioned as a sort of "nanopencil" that could be tapped on a surface, leaving pieces of thin graphite.

But as it turns out, the best method for capturing graphene is … cellophane tape (you may know it better by its brand name, Scotch tape).

A group of scientists at Manchester University in England placed a speck of graphite on a piece of tape, then folded it over and pulled it apart — and folded it over and pulled it apart, over and over again. With each folding and unfolding, the graphite became thinner and thinner, until eventually some of those specks were one atom thick. *Voila!* We have graphene.

"Since the development of the tape method people have fabricated larger area graphene by using other methods," said Cadden-Zimansky. "However, for getting the highest quality graphene, the cellophane-tape method is still what's employed."

In a pinch, 3-D glasses will do

One day, a user was working in SCM3 (that's the name of a magnet, but for these purposes, you can think of it as a secret underground military installation). He was doing optics experiments* on semiconductor nanocrystals that were going so well, he decided he wanted to take additional measurements. Doing so would require a thin-film circular polarizer, and that moment, there wasn't enough time to order it from a distributor. Data was on the line!

That's when Mag Lab physicist Steve McGill started thinking about 3-D movies.

Huh?

You see, McGill had recently seen a 3-D film and worn the Real-D glasses.

"In the past, I have not been a fan of 3-D films because experiencing the 3-D effect for long periods of time usually gave me a headache," said McGill. "However, I was pleasantly surprised to discover that I did not suffer these side effects with the newer technology that's being used in films today."

So like any self-professed science nerd would, he brought a pair of the Real-D glasses home to play with.

"I discovered that the lenses in these glasses are actually circular polarizers," said McGill. "Anyone can easily verify this by putting them on, closing one eye, and then looking at his/her reflection in a mirror. Since right and left circular polarization are exchanged upon reflection, the wearer will notice that the lens over the open eye looks dark in the mirror, while the lens over the closed eye appears clear."

***Warning: scientific language ahead. Proceed with caution. The scientist was measuring the magnetic field-dependent intensity and energy of photoluminescence emitted from semiconductor nanocrystals. He wanted to get more information and so figured that he should record the degree of polarization of the photoluminescence as well. Photoluminescence emitted from these nanocrystals is circularly-polarized, hence the need for the polarizer.**

Experimental physics is just as cerebral, though not always as tidy, as you'd imagine. *Photo by Larry Gordon*

As the user anxiously awaited word about his experiment's fate, McGill raced home (OK, he *drove* home) to retrieve the glasses.

Safely back at SCM3, McGill and the visiting scientist performed delicate surgery on the lenses (they cut one out), placed it in the probe, and the measurement was successful. No additional magnet time was required!

Let there be light

The 900 MHz superconducting magnet is one of a kind. With a magnetic field strength of 21.1 tesla, it pushes the limits of current magnet technology. You may have never heard of a thing such as a superconducting magnet, but if you've ever had an MRI scan, you've been in one. The 900 is like a supersized version of a hospital MRI, which is only about 2 tesla.

"Tesla" is the scientific unit of measure of magnetic field strength; to put the 900's power in perspective, The Earth's magnetic field is one twenty thousandth of a tesla. And while 21.1 tesla is plenty strong, what makes the 900 special is the size of its bore, the place in the middle of the magnet where the experiments go. At about 4 inches in diameter, the 900's bore is about as wide as an orange. Other magnets of comparable field have typical bore sizes of two inches. Because of its large bore size, the 900 can be used to study small living animals. So you could (and we do) call the 900 the **strongest MRI scanner in the world**.

Imagine the possibilities! An MRI scanner with that much resolution could be used to study all kinds of neurological and other diseases in animal models. But you can only do research if you can see what you're doing. And lighting the 900 pit—which is a "bottom loading" magnet, hence the pit—is not as easy as it sounds.

How in the world do you light a magnet whose very properties cause lights not to work properly? Clues and possible treatments for Parkinson's, Lou Gehrig's disease, muscular dystrophy and more are just waiting to be discovered! There has to be a way to light the pit so that scientists can see well when putting probes into the magnet.

Low-voltage landscape lights solved the problem of lighting the 900. *Photo by Ray Stanyard*

"In the stray field of the magnet, most light bulbs don't work," said Bill Brey, a scholar scientist and probe engineer in the lab's Nuclear Magnetic Resonance user program. "The filaments in incandescent bulbs will shake due the field and quickly break; the electrons in fluorescent tubes will veer off into the wall of the tube—so the tubes don't light."

Brey's team thought they had the answer with the new low energy light emitting diode (LED) bulbs. But as it turned out, the LED bulbs worked for a few months, then quit.

"There are magnetic parts in the voltage converters that allow the bulbs to run off the 110 V lab wiring," said Brey. No matter how tiny they may be, magnetic parts in a magnetic field present problems. So Brey turned to low-voltage LED landscape lights.

"They have aluminum or plastic housings to avoid rust, so we can use them in our stray field zone," said Brey. "And they don't have the voltage converters of the old lights."

And just like that, Mag Lab MacGyvers helped push the frontiers of science while saving researchers unnecessary eyestrain.

"We are not above using everyday products in our research," said Brey. Even in his grad school days, Brey tinkered. "My wife saw me making a radio frequency shield for an animal MRI coil out of a file folder and aluminum foil, and of course Scotch tape, back in grad school," said Brey. "That shield worked well, too."

High-tech lab, low-tech tape

Scotch, duct, electrical — tape is often employed at the Magnet Lab. Even the lab director's graduate students use it. Here, graduate student Scott Riggs shows creative use of electrical tape to hold a 2 x 4 in place to support the electrical cable that connects the sample to the measurement electronics.
Photo by Kristen Coyne

Classroom outreach plants science seed in students

By Amy Mast

The Magnet Lab, at 370,000 square feet, is a pretty big place. But the lab's Center for Integrating Research and Learning (CIRL) reaches miles and miles beyond the lab's front door. The CIRL team goes to classrooms all over the region—from South Florida to South Georgia—demonstrating science concepts and more importantly, teaching kids to investigate the world around them.

K-12 Education Outreach Coordinator Carlos R. Villa walks into a classroom and plunks down a large toolbox full of … who knows? He's not telling yet. Several of the students make unnecessary trips past the box to wash their hands or sharpen pencils, trying to get a peek inside.

Today he's visiting fifth-graders at W.T. Moore, a Tallahassee elementary school. He starts off by asking if any of the students know anything about sea turtles. Lots of hands go up.

"They have shells."

"They walk slow."

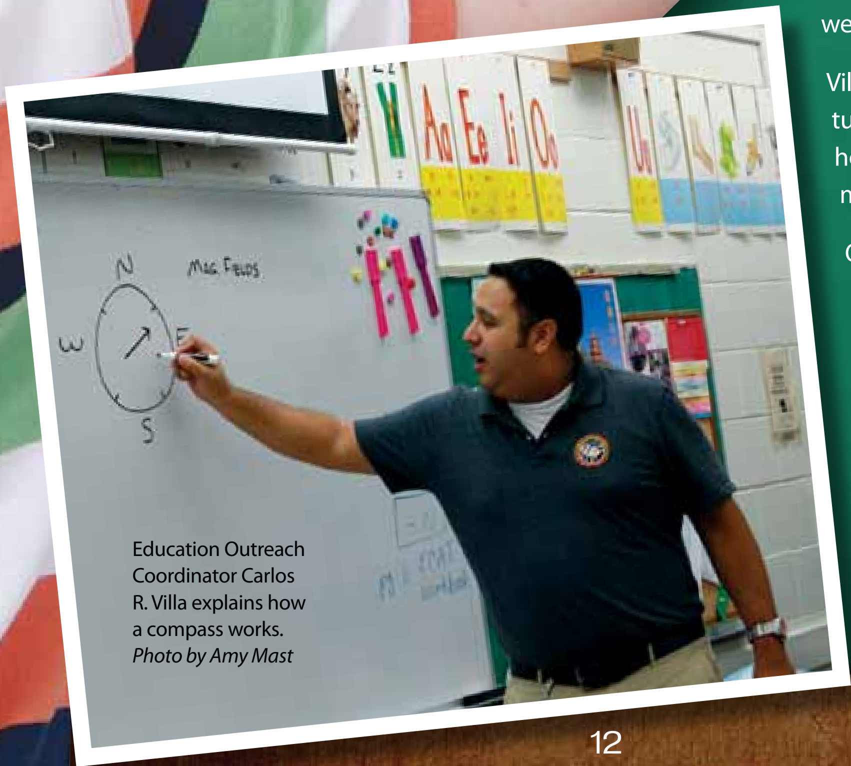
"They go back to the beach where they were born and lay their eggs."

Villa picks up on this point. "How can the turtles swim all over the world and know how to get back home? Do they have maps?"

One child answers, "Magnetic fields!"

"Absolutely," says Villa. "We have found that some animals can detect the Earth's magnetic field and navigate with it."

Villa goes on to talk about the various creatures—pigeons, hammerhead sharks, even dairy cows—that have a migratory (or in the case of cows, still unexplained) relationship to the



Education Outreach Coordinator Carlos R. Villa explains how a compass works. *Photo by Amy Mast*

Earth's magnetic field. Then he offers the classroom a chance to make its own navigation device: a homemade compass.

One expects to see step-by-step worksheets handed out across the room, but no such shuffle of paper ensues.

"Here's the thing," Villa explains. "We've talked a little bit about magnets, and we've talked a little bit about how a compass works. You've got clues, and you have all these materials, but I'm not going to tell you how to make it. You can make a very simple compass or a very complicated one; there is more than one right answer."

A chorus of response bursts from the students, some up for the challenge, some rolling their eyes. Each team of students has in front of them a couple of plastic discs, a needle, some of those tiny straws you'd use to stir coffee, a couple of paper clips, a bar magnet, and a petri dish filled with water. Hmm.

More than a dozen miniature experiments erupt at once, paper clips mangled and balancing precariously, bar magnets plunked into dishes, needles slid inside straws. Water is spilled and drips off desks. Even the eye-rollers start to get involved in this crazy assignment that doesn't have directions.

Gradually, the teams figure it out. The bar magnet is too heavy to point toward north, and it can't float in the water. The teams move on to the paper clips, then the needles, and a-ha! A needle on a

A student team in the early stages of making its compass.
Photo by Amy Mast

floating disc will face toward North! So will a needle floating inside one of the tiny straws!

The children with the successful experiment attract their own share of very casual passers-by, who then go back to their desks and replicate the "winning" design. But even then, tinkering takes over—will the newly created compass work with this variation? How about with this one?

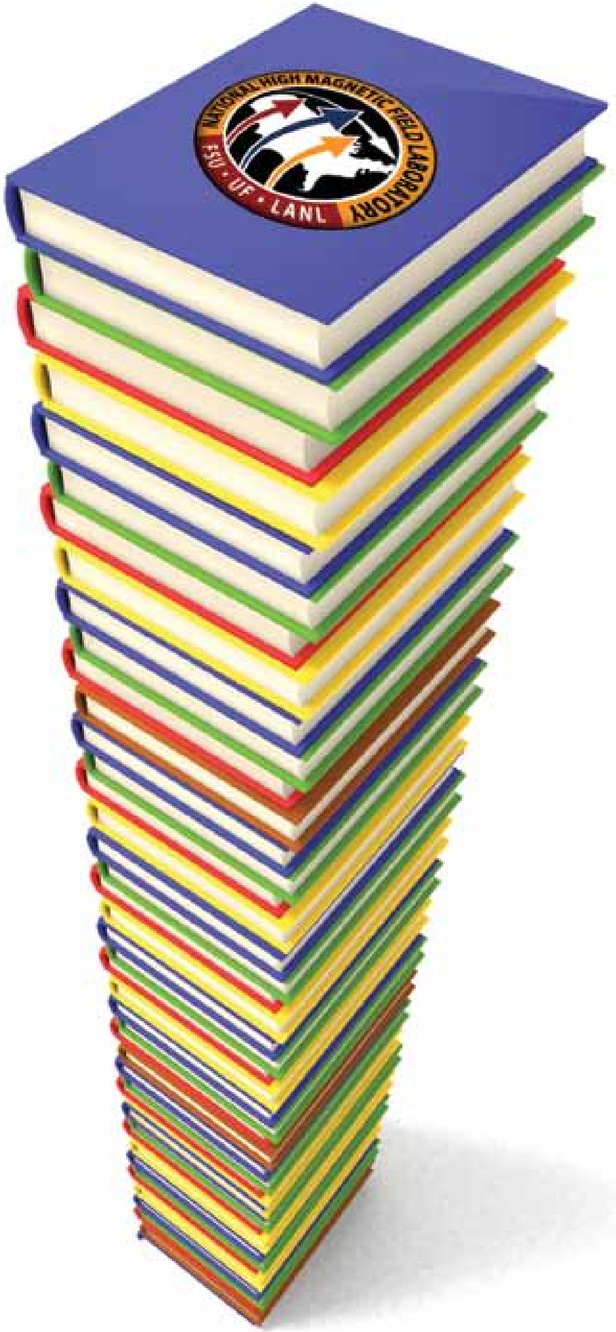
Teacher materials reinforce lessons

All told, CIRL staff reaches more than 8,000 students a year with both outreach and in-house programs designed to get young kids thinking scientifically and to introduce older children to science as a career option. To ensure the lesson sticks, teachers are offered pre-and-post lesson materials aimed at placing the demonstrations squarely in the context of the students' larger science curriculum.

For students visiting the lab, the demonstrations are combined with a tour, but for classroom visits, teachers can choose from about 20 different demonstrations, ensuring that even the youngest grade-schoolers can experience science in a hands-on way.

Candi Kalfas has been using CIRL demonstrations as part of her classroom's science experience for years. "It is unbelievable to see the kids' reaction. The next day, I asked them what they thought of science period the day before and the whole class lit up and

Two teams race to complete their compass designs — while trying to hide their techniques from each other. Photo *by Amy Mast*



Compass materials ready for the next go-round. *Photo by Amy Mast*

all started talking at once. I think that hands-on activities are priceless! Carlos does such a wonderful job of getting the students excited and making the lesson relevant to what they are learning in the classroom," she said.

All of CIRL's programs are developed in close collaboration with research scientists and educators. Housed at the Magnet Lab, the Center is uniquely positioned to take advantage of the excellent resources, connections, world-class facilities and cutting-edge science the lab has to offer. CIRL is supported by the National Science Foundation and the State of Florida, and also applies for and receives several project-directed grants.

It's time for the next class, and with a flurry of books and snacks a new group of students shuffles in. Villa starts all over again, in a totally different way. On some days he'll do the same demonstration five different times or visit several different schools, and he often goes back to the same classrooms several times a year, bringing a new demonstration each time. And with each demonstration, students learn that science is more about learning how to ask the right questions than getting the right answer.

Outreach activities

CIRL offers too many types of classroom experiences to list here, but below is a sampling. To learn more about classroom outreach at the Magnet Lab and see the full list of demonstrations offered, contact Carlos R. Villa at villa@magnet.fsu.edu or visit: www.magnet.fsu.edu/education/teachers/resources/classroomoutreach.

Liquid Nitrogen: The Coolest Show

This demonstration shows just how cold things can get, and how some materials will behave differently at low temperatures.

What Is a Scientist: Explore the World Around You

This outreach introduces students to the subject of science, explains how scientists and engineers work day in and day out, and gets them thinking about the way they view science. Then students use their observational skills to explore magnets of different shapes and sizes, and make some amazing discoveries.

Superconductivity: A Matter of Temperature

Students drive a discussion on principles and properties of magnets, then construct their own electromagnets and test them. After discussing the variables that affect the strength of their magnets, they will see how temperature is the ultimate variable. The lesson concludes with an explanation and demonstration of the Meissner effect.

Electricity, Static & Currents: The Power All Around Us

The motion of charged particles creates magnetic fields, but the actual motion of those particles is just as important as the fields they create. This activity aims to show what electricity is and how it travels. Students will create series circuits and parallel circuits using light bulbs as test units, then will see a Van de Graaff generator create electric sparks that can be used to transfer charges.

OTHER WAYS CIRL REACHES STUDENTS

- *High School Externship:* Supervised by scientists, exceptional high school students conduct their own in-depth research at the Magnet Lab.
- *Middle School Mentorship Program:* A partnership with the School of Arts & Sciences in Tallahassee.
- *SciGirls Summer Camp:* A two-week, hands-on camp run by the Magnet Lab and WFSU that inspires girls to pursue careers in science.
- *Summer Energy Program:* High school students and teachers conduct research and learn about power grids, environmentally responsible power systems, renewable energy, and current and future power delivery systems.

To learn more about any of these programs, visit: www.magnet.fsu.edu/education/students

Want to check CIRL demonstrations out for yourself?
Visit the education section on the Magnet Lab website. Here, Jose Sanchez prepares to demonstrate how atmospheric pressure affects different objects. See them all at http://www.magnet.fsu.edu/education/tutorials/slideshows/

PHYSICS FIREBRAND

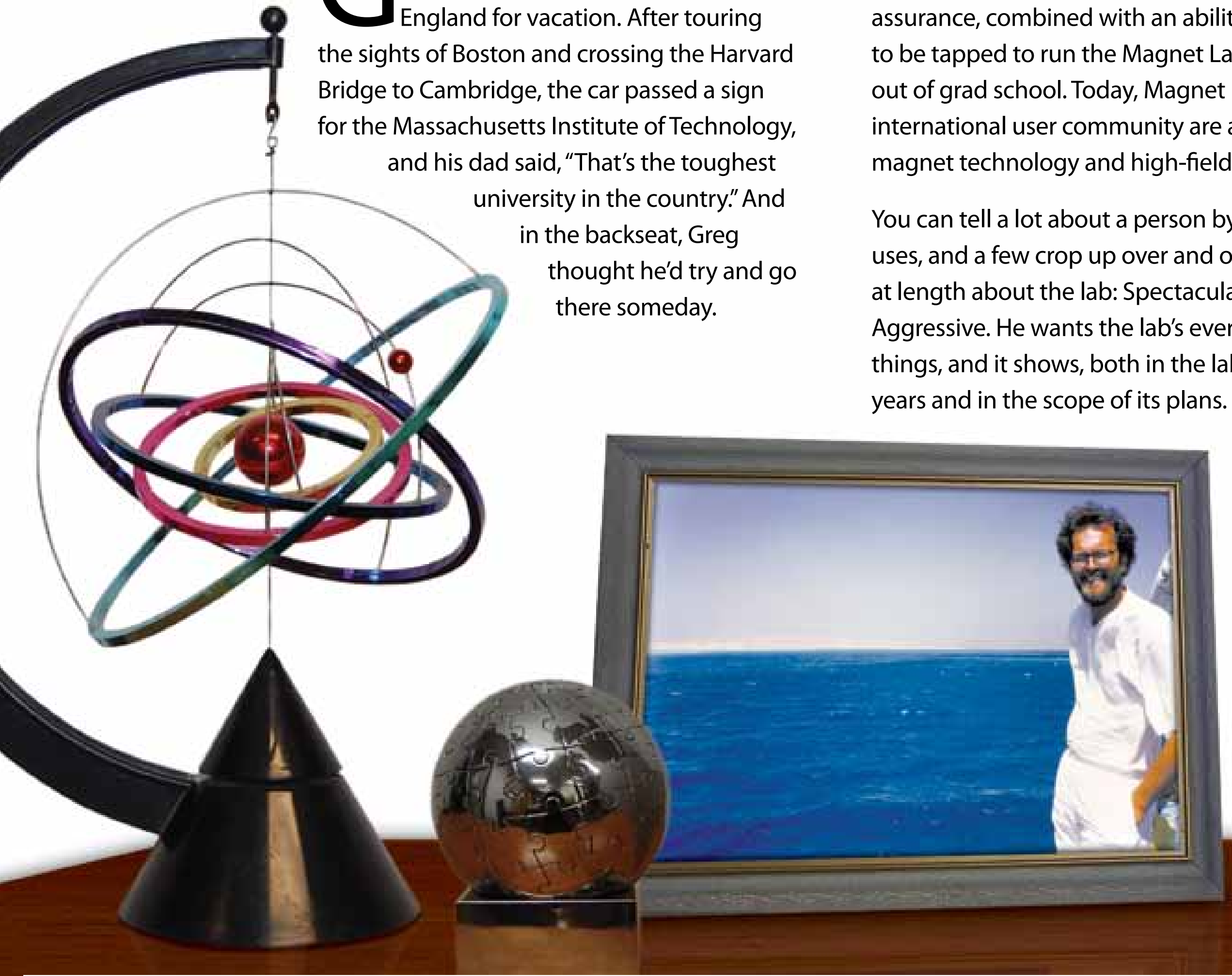
Magnet Lab Director Greg Boebinger is just warming up.

BY AMY MAST

Greg Boebinger was 9, sitting in the back seat as the family drove to New England for vacation. After touring the sights of Boston and crossing the Harvard Bridge to Cambridge, the car passed a sign for the Massachusetts Institute of Technology, and his dad said, “That’s the toughest university in the country.” And in the backseat, Greg thought he’d try and go there someday.

Pretty decisive for a 9-year-old, but not surprising considering that same kid had already met the girl he would marry. That assurance, combined with an ability to get results, buoyed him to be tapped to run the Magnet Lab at 44, less than two decades out of grad school. Today, Magnet Lab researchers and its international user community are advancing on many fronts in magnet technology and high-field research.

You can tell a lot about a person by the descriptive words he uses, and a few crop up over and over when Boebinger speaks at length about the lab: Spectacular. Ambitious. Fantastic. Aggressive. He wants the lab’s every project to be all of these things, and it shows, both in the lab’s growth over the past five years and in the scope of its plans.



Longtime colleague and friend Al Migliori calls Boebinger “energetic, honest and extremely intelligent” as a leader and a “wild man” as a scientist — a pairing that suits Boebinger’s dual role as a leader and a researcher.

This dual role will be challenged more and more as Boebinger spearheads appeals for several ambitious new projects while trying to maintain the lab's leadership role in an ever more competitive field of international research.

Engineer, philosopher, physicist

After high-school graduation, Boebinger, one of four sons of an Indianapolis minister and an elementary school teacher, headed to Purdue University and took up an electrical engineering major, just like his older brother. Once he got there and confronted the prospect of being an electrical engineer as a profession, however, his enthusiasm dimmed, and he added a philosophy major to his plans.

By 1979, his older brother was an electrical engineer at IBM in Tucson, Arizona, and Boebinger spent the summer working with him. While he was there he visited Kitt Peak and was fascinated by the studies at the famous National Optical Astronomy Observatory. He realized that astronomy and engineering were powered by a common field of study, physics, which interested him more than anything before. He added a third major.

During his later years at Purdue, his favorite physics professor urged him to apply to top-notch physics graduate programs, while his favorite electrical engineering professor warned that there were better careers to be found in engineering. Unsure, Boebinger toured several physics departments and met the director of the MIT Francis Bitter National Magnet Laboratory, Peter Wolff.

"He was an absolutely spectacular personality, representing a fantastically dynamic laboratory, and it was all located at MIT, which looking back had been part of my imagination for so long," Boebinger said.

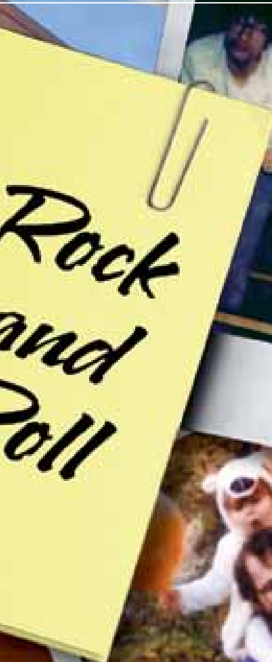
Bound for MIT at his Purdue graduation, he posed for photographs with three tassels—one for electrical engineering, one for philosophy, and one for physics—dangling from his mortarboard.

At the forefront of new physics

After marrying his wife Karen — the lass he'd spied at 9 and started dating in high school — Boebinger deferred admission to MIT. The young couple traveled to Cambridge University in England, where he spent a year as a Winston Churchill Foundation Fellow doing research on organic superconductors. "It was like a yearlong honeymoon, without any money or heat," said Boebinger.

Settling in at MIT, Boebinger was introduced to magnet science just as the then-fledgling field was being shaken up by the discovery of the fractional quantum Hall effect. The effect is a still-studied phenomenon in which, when a specific magnetic field is applied, special resistance-free electrically conducting states occur for ultra-thin sheets of semiconductors.

Horst Stormer of Bell Labs and Dan Tsui of Princeton University regularly visited the MIT magnet lab. They began to realize that they might need a graduate student to keep the magnet lab fires burning and further advance the lab's increasingly sophisticated equipment. Boebinger needed a thesis adviser. At the beginning of his second year at MIT, he got a call from the MIT magnet lab director Wolff: "Horst Stormer and Dan Tsui want to interview you *right now*."

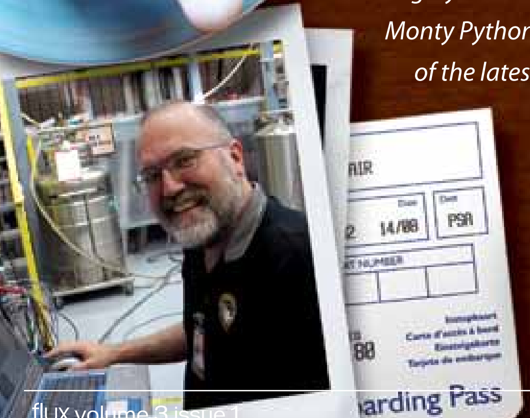


Boebinger ran the half-mile to the magnet lab, arriving nervous and sweaty, ready to be grilled. Tsui smiled and said, "So, you're joining our lab."

With that, Boebinger began working with a team whose research would result in Nobel Prizes for both its leaders, and whose work would heavily influence the direction and ambition of his own. Boebinger soon fell in comfortably with the group.

Stormer, now retired from Columbia University, wrote of Boebinger's role on the team:

"These were the early days of the fractional quantum Hall effect and many late evening runs were devoted to finding and characterizing new fractions. Hundreds of resistance traces were recorded with colorful ink on shiny millimeter paper around the roaring magnets. While necessary for progress, it wasn't always the most exciting work. To liven up the drudgery and stay awake, the group fell into silly Monty Python songs crowned by Greg's narration of the latest "stupid pet trick" from the David Letterman show, to bellowing laughter from his audience. It all kept us going, and it established Greg as the great storyteller who knew what mattered to get first-rate results — tenacity and a good sense of humor to make it through."



Joining the 'neural network'

Having established a relationship with Stormer and Tsui and completed a graduate thesis he was proud of, Boebinger headed back to Europe with Karen for a one-year postdoc in Paris — a year Boebinger described wryly as more Paris than postdoc.

When the year ended, Boebinger accepted a position at Bell Labs, a laboratory that he had admired since his first days as an undergraduate electrical engineering student.

Bell Labs, in those years a subsidiary of AT&T, was a nexus of research and discovery. Historically the premier research center of its kind in the world, it is known for the development of key technologies such as the transistor, the laser, wireless networking, and important computer operating systems. For Boebinger, who shied away from the competitive grant-based world of academic physics but thrived on intellectual competition, it was a dream job.

"It was so appealing to go to a place like Bell Labs where you are part of a bigger neural network— in fact, that's how they describe it. If you isolate yourself in your own lab and you do great things, that's spectacular but you should probably not be at Bell Labs," said Boebinger. "What they wanted was someone who was also out in the hallways, talking and arguing and contributing to a whole greater than the sum of its parts. And as long as you were arguing the science, there was no hierarchy."

At Bell Labs, Boebinger built a pulsed magnet lab with his technician Al Passner and enjoyed the exhilarating, combative and fraternal environment the research institute was famous for. It was there that he honed his communication style.

"One thing I get from my father is a gregarious personality that likes to stand at the pulpit and perform. There's a certain drama, there's a certain delivery, and I think he was even more fearless than I am when it comes to dealing with people. It worked very well at Bell Labs to have an ability to either make people laugh or to have an ability to hold your own in hand-to-hand combat—I mean debate," said Boebinger.

After eight years of downsizing at Bell Labs, he started to realize that the intensity was taking its toll, but he would stay almost three more before he found an opportunity he couldn't turn down. "It wasn't until after I left that I realized how rarely I slept through the night," he said.

A dream is realized

Even as a grad student, Boebinger had thought about one day running the Francis Bitter Magnet Lab at MIT.

"I was among the people who, as a user at MIT, thought the decision to move the Magnet Lab to Tallahassee was a disaster," said Boebinger. "At the time, the FSU/UF/LANL consortium was an initiative with no infrastructure and very little expertise," he said. But by the time he was offered the job to run the new Magnet Lab's Pulsed Field Facility at Los Alamos National Laboratory in 1998, he had seen the new Magnet Lab become a huge success, with promise for even more.

Boebinger wrestled with the decision, but made up his mind after a conversation with Doug Scalapino, a theoretical physicist at UC Santa Barbara.

"He said, 'What if you turn down the job offer and they give it to someone else and that person does a terrible job and the thing just collapses?' I told him that I'd feel terrible. Then Doug asked, 'What if you turn down the job offer, they give it to someone else and that person does an absolutely spectacular job?' And I said 'Well, I'd feel even worse.' At which point Doug concluded, 'Then you have no choice. You have to take that job.'

"How could I argue with that kind of analysis? In fact, it's an analysis I've applied several times since then."

Boebinger was eager to "mix a little bit of Bell Labs" into the magnet program at Los Alamos, a process that began even before his first day, as he planned a workspace floor plan that he felt would encourage the exchange of ideas and, hence, increase scientific productivity. Under his five-year watch, the Magnet Lab's pulsed magnet user program quadrupled the number of scientific publications, an accomplishment Boebinger attributes to increased productivity among existing staff, new hires that energized the team, and grants that substantially pumped up the budget.

Boebinger also points to a great relationship with his boss, Magnet Lab Director Jack Crow, as a key to his success at LANL. "My relationship with Jack was spectacular. At Los Alamos, I think he liked what I was doing, so he was pretty hands-off. When I needed help, he was there—with advice and the funds needed to launch the 100 tesla magnet project," he said.

A new challenge

Boebinger's success at Los Alamos did not go unnoticed. In 2004 he was invited to run the Magnet Lab, only a few short months before founding director Jack Crow passed away. As the staff mourned Crow's passing and considered his legacy, Boebinger was tasked with figuring out how to put his own stamp on a research institution that literally wouldn't be there without his predecessor.

Though he says he was at first acutely aware of his newness, Boebinger settled in quickly, and he says he has learned a lot from balancing his own research with guiding the direction of the lab.

"As far as I'm concerned, managing scientists is a scientific experiment in itself," he said.

Managing scientists, Boebinger thinks, requires a lighter touch than is used in a traditional business model. "With the best scientists and engineers, you want to provide the environment and, occasionally, even the goals, and then you need to get out of the way."

"There are so many ways to manage scientists incorrectly," he said. "In the private sector, it's increasingly become a creative job without a creative corporate structure, and it's getting worse. In the private sector as well as in academia, scientific productivity in the U.S. is being seriously hamstrung by the number of non-scientific chores that scientists are forced to address."

Glossary

Series connected hybrid:

A new kind of magnet combining superconducting and resistive magnets run with the same power supply, rather than independently as in traditional hybrid magnets.

Hybrid magnet:

A magnet that uses resistive and superconducting magnet technology fueled by different power supplies.

Pulse magnet:

This type of magnet can create a very high magnetic field, but only for a few seconds (or less!). The lab's pulsed magnets are located at its Los Alamos, NM facility.

In addition to managing the lab's principal investigators, Boebinger supervises graduate students who assist him in his own research. He's quick to point out that he wishes he had more time with them and that his Magnet Lab collaborators at Los Alamos have pitched in to help.

Scott Riggs, an FSU grad and now one of Boebinger's graduate students, decided to stay at FSU for grad school after hearing Boebinger speak.

"Greg's strength—and what he's always there for—is to go through the data, help you understand, and guide you as you write your paper. And he still has the same passion for that process of discovery as we graduate students," said Riggs.

Setting an ambitious agenda

The view from the director's office hasn't slowed the ambition Boebinger showed in the high-pressure hallways at Bell Labs. Ask him what one improvement he'd most like to see at the Magnet Lab and his answer is immediate: "Substantially improve the signal-to-noise ratio for our users."

Signal–to-noise ratio describes the quality of data you get from an experiment. "Signal" is the information a researcher is trying to receive, and "noise" refers to the electrical or other interference that degrades the quality of the data. Doing research with instruments that don't filter out unwanted noise is like listening to a radio news story filled with static; you may not be able to understand anything. Or you may get the gist of what the story's about, but you won't know the details. And in science, the details matter a great deal. In developing techniques to improve the signal-to-noise ratio, Magnet Lab scientists are enabling experiments that match the quality of our magnets.

"Better experimental techniques plus bigger magnets equals scientific capabilities worth traveling around the globe to use," said Boebinger.

In the next decade, Boebinger's aiming to have a couple of **series connected hybrid** magnets up and running. Though startup costs are steep, these magnets have the potential to simultaneously revolutionize research quality and quantity because they use much less energy to operate. One such magnet is already being built thanks to an $11.7 million grant from the National Science Foundation.

Eventually, Boebinger would like to see a **hybrid magnet** capable of reaching 60 tesla and **pulse magnets** that reach past 100 tesla. He's also betting on high-temperature superconducting magnets that have revolutionized magnetic resonance, including MRIs.

He's also advocating for the placement of a free electron laser at the main Tallahassee campus of Magnet Lab—a project dubbed Big Light. It's an initiative comparable in audacity to the construction of the Magnet Lab itself. The laser would stretch half the distance of a football field and further increase the scientific impact of the Magnet Lab's unique magnets.

Though the project cost is measured in the "tens of millions," Boebinger argues that it's critically important that the U.S. lead in terahertz research, because central questions in energy, security, and fundamental science are best studied in this little-explored regime. "Because of the infrastructure and expertise we already have in place, if we're going to build it anywhere in the country, there's a good argument it should be built here, where Big Light would be the laser best designed to match the energies provided by our big magnets," Boebinger said.

'We want to be the best'

The success of the Magnet Lab's user programs, Boebinger says, has provided an impetus to increase funding for other nations to step up their own magnet research and facilities. "In Europe, there are now four labs that are firing on all cylinders and represent serious and exciting competition," he said.

"It is clear that Europe in particular, plus Japan and China, are now investing tens of millions of dollars to advance their own magnet capabilities," said Boebinger, who recently visited the leading European laboratories, as well as the sites for two Chinese labs under construction.

The increased international competition and the exchanges of scientific and technical ideas that result do put pressure on the Magnet Lab to protect its reputation as the world leader. "Real competition is hugely important to stimulate research. So everybody wins in the end," Boebinger explained, adding, "Of course, we still want to be the best."

High tech spool is one big bobbin

BY AMY MAST

The Magnet Lab's magnet-building team has a way of customizing even the most straightforward tools of its trade. Take this "**cable-in-conduit conductor**" spool.

When superconducting cable-in-conduit is made, the cable itself (pictured here) is squished into a rectangular shape using a torturous-looking device called a tube mill.

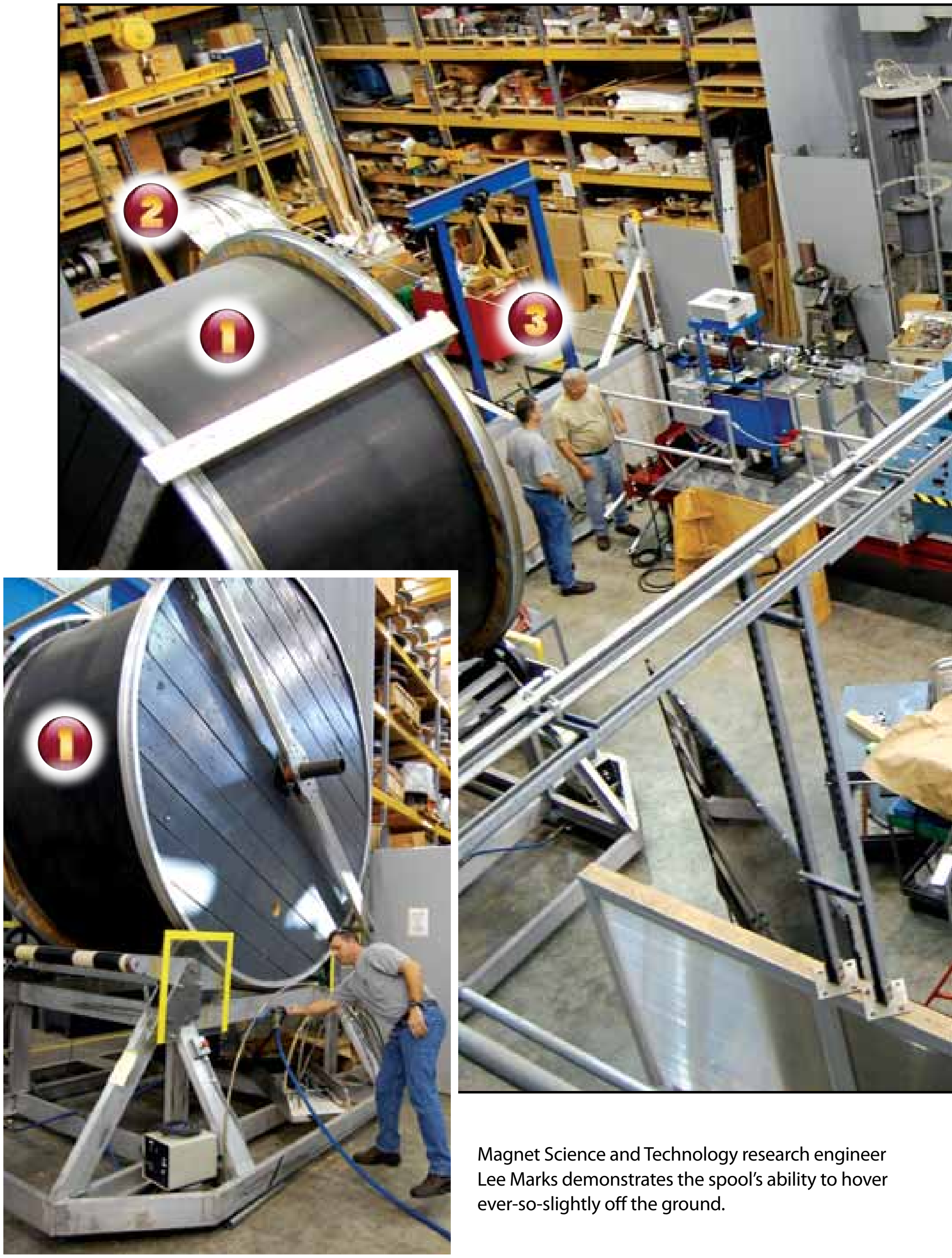
The cable is formed into this shape in one long, continuous section, which presents some logistical problems; namely, what one does with more than a thousand unbroken yards of metal? The answer: you wind it, very carefully, onto this giant spool in the same way you'd take up thread into a sewing machine.

The spool has to be supersized because winding it around anything smaller could put unwanted stress on the metal. Winding the cable is a time-consuming process, with about four feet of cable completed per minute. Though commercial versions of this machine can go as fast as 1000 feet per minute, the lab's span of cable-in-conduit may represent as much as a million dollars' worth of materials, so technicians use extreme care.

What don't you expect from a structure this size? It floats. Air pads on the bottom of the spool help technicians to move the loaded-up piece of equipment from one area of the workspace to another. This is also handy for making minute adjustments during the coil take-up process.

The spool will be used for the eventual replacement of the 45 T hybrid "A" coil.

1 Cable-in-conduit-conductor tube-up spool



Magnet Science and Technology research engineer Lee Marks demonstrates the spool's ability to hover ever-so-slightly off the ground.

2 Smaller spool

3 Magnetic cable

4 Magnet body

5 Tube mill

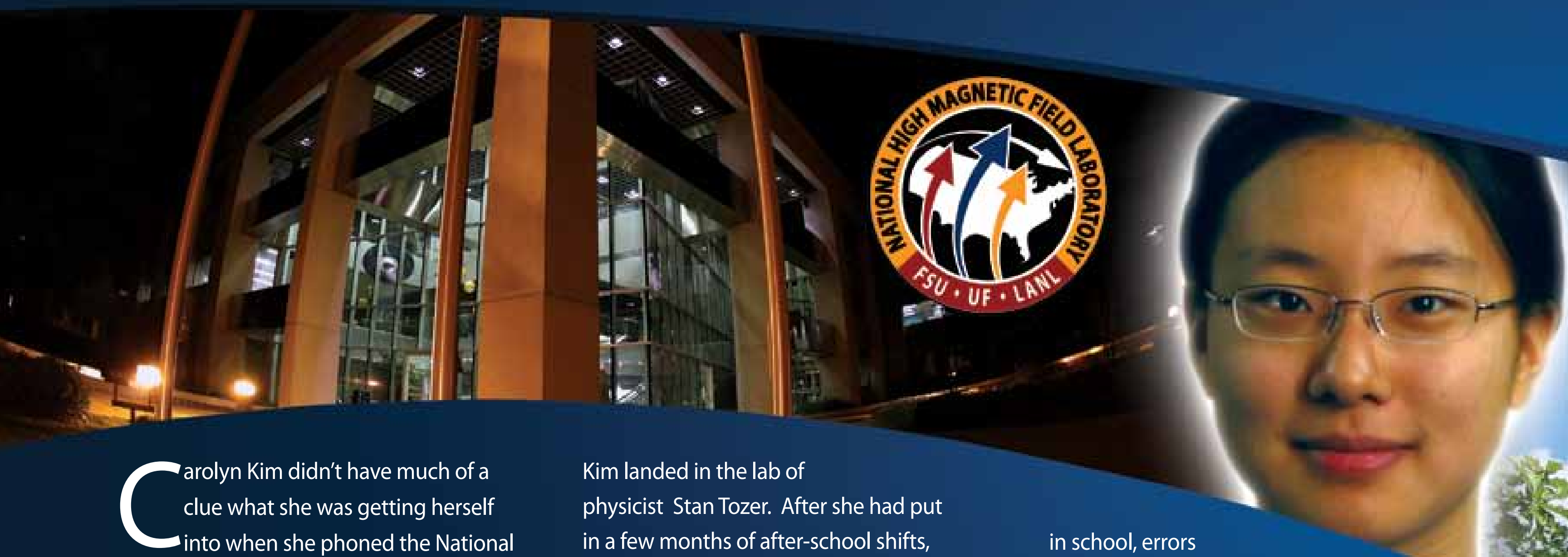
LEARN MORE

➤ *What is cable-in-conduit conductor?*

Cable-in-conduit conductor is used to make the superconducting part of hybrid magnets, which are part resistive magnet (made of copper plates), part superconducting magnet. CICC, as it's called, is made of 270 superdconducting wires (to see an animation of how they are made, visit www.magnet.fsu.edu and search for "six superconducting cables"). Unlike copper, which is used to make our resistive magnets, superconductors conduct electricity with no resistance, or friction. That means once current is flowing, it flows and flows and flows unimpeded as long as the cable is cooled to very low temperatures.

Lessons learned at Mag Lab paying dividends for Harvard freshman

BY KRISTEN COYNE



Carolyn Kim didn't have much of a clue what she was getting herself into when she phoned the National High Magnetic Field Laboratory one day during her junior year at Tallahassee's Leon High School and said she wanted to volunteer.

"I had taken a lot of science courses but I'd never been in a lab or known what scientists really do," says Kim. "I just wanted a chance to experience how things work in a lab."

So for the next two years, Kim took a two-pronged approach to studying science. At school there were her books, homework and exams. At the lab there was work that challenged her on many levels, testing her hands, her mind and even her character.

Kim landed in the lab of physicist Stan Tozer. After she had put in a few months of after-school shifts, Tozer was impressed enough to put the her on staff. More than a year away from a high-school diploma, Kim was pulling down a salary at one of the nation's most prestigious laboratories.

"The graduate students and postdocs were scared of her — she was *sooo* smart," Tozer said. "She sat down, she listened and she did it. So we figured, 'Get her on board.'"

At the Magnet Lab, Kim saw science in action. It was less about the laws and equations *of* science than the kind of grit it takes to *do* science.

In Tozer's lab, Kim saw her conception of mistakes turned on its head. On exams in school, errors were bad and punished with lower grades. But in a real lab environment, mistakes are not only inevitable, Kim learned, but often plentiful — and an invaluable part of science.

Kim made tiny gaskets and even tinier coils for use in Tozer's experiments. Fashioning the miniscule tools was hard — "I didn't know they made wires that thin," she says — and many of her creations ended up in the trash.

"I think I learned that a lot of what scientists do involves a lot of errors, and you have to be very patient," says Kim. "When I was trying to do things I messed up all the time — and that was pretty informative."

It was also informative to see Tozer and the rest of his group wrestling with their own snafus. When running experiments in the magnets, the scientists would stay late into the night — sometimes early into the morning — as they trouble-shot problems. "They were trying to figure out what's wrong with it," Kim says, "and they kept on trying different things."

Which taught her another lesson not revealed in textbooks: To succeed, you need to stick with it.

"I kind of learned to be patient and to not give up, to be persistent in what I do," says Kim.

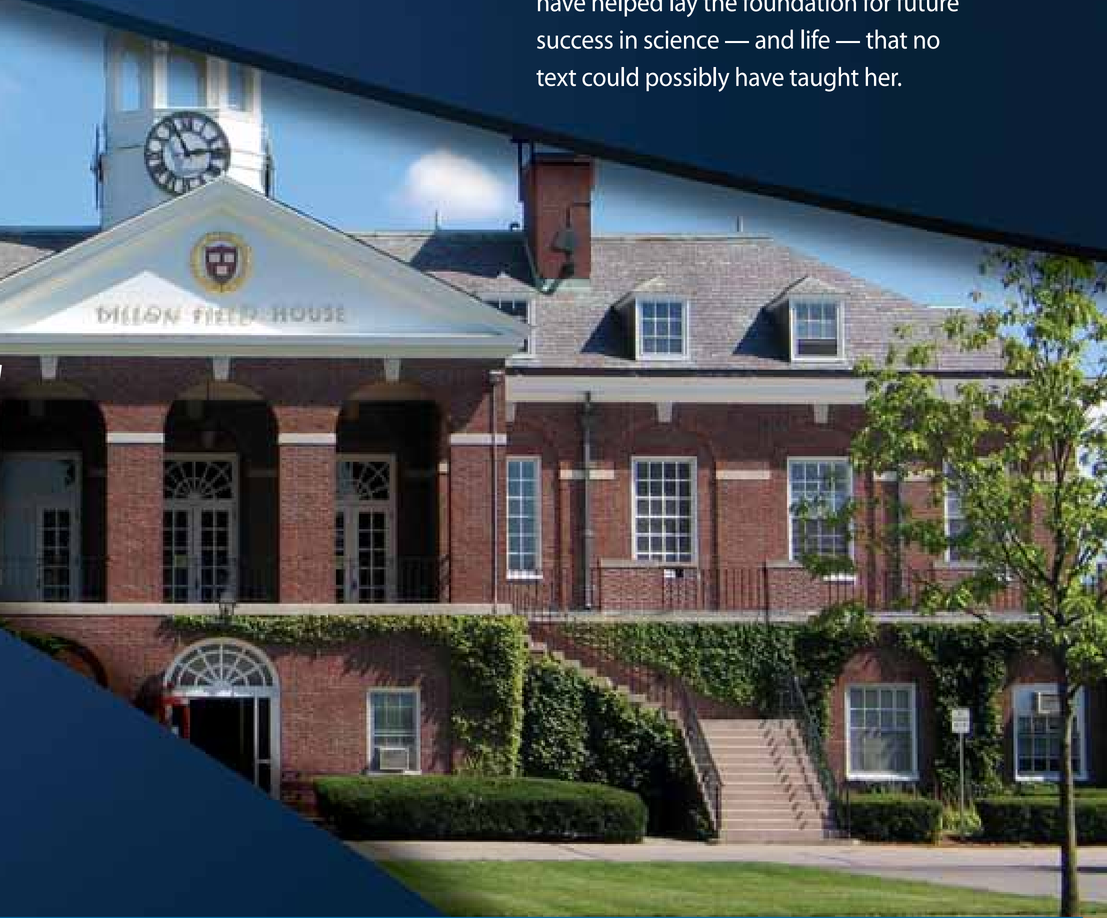
As she got the knack of gasket-making and other lab tasks, Kim was often left alone to complete projects. At first she was surprised to be left unsupervised. Then she was surprised, and pleased, to learn she could direct herself just fine, driven by her own curiosity and desire to do good work.

"Sometimes they would tell me to do something and they wouldn't watch over me or anything," Kim says. "I would learn to do my own work and be responsible for my own work, which is what I have to do in college."

That hands-off approach to mentoring was no accident.

"I just want them to be self-starters," says Tozer of his junior staff. "We try to wean the student of any misconception they have that we're going to tell them how to do it. Hopefully they fail miserably a few times and then come to us with questions. It's a model that works pretty well."

Those skills are paying dividends for Kim, now a freshman at Harvard University. She isn't sure yet what field she'll pursue, though it will almost certainly be in science or math. Regardless of her path, the patience, persistence and responsibility she learned at the Mag Lab have helped lay the foundation for future success in science — and life — that no text could possibly have taught her.



During her time at the Magnet Lab, Kim worked on incredibly tiny coils such as the one shown here.
Photo by Kristen Coyne

A portrait of magnetism: drawing field lines

BY CARLOS R. VILLA & FLUX STAFF

Magnets have two poles; the field lines spread out from the north pole and circle back around to the south pole. In this activity, you'll watch field lines materialize before your very eyes. The invisible will be made visible thanks to a handful of tiny iron filings.

What you'll need:

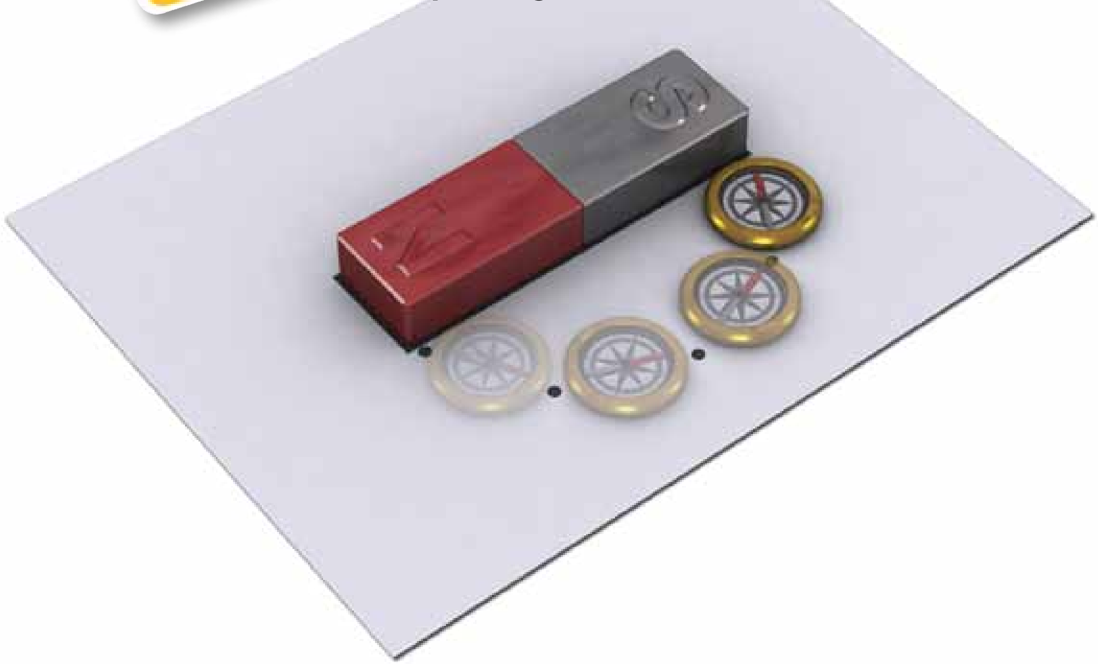
1. A bar magnet
2. A piece of white paper
3. A pencil or pen
4. A compass

WHAT YOU'LL DO:

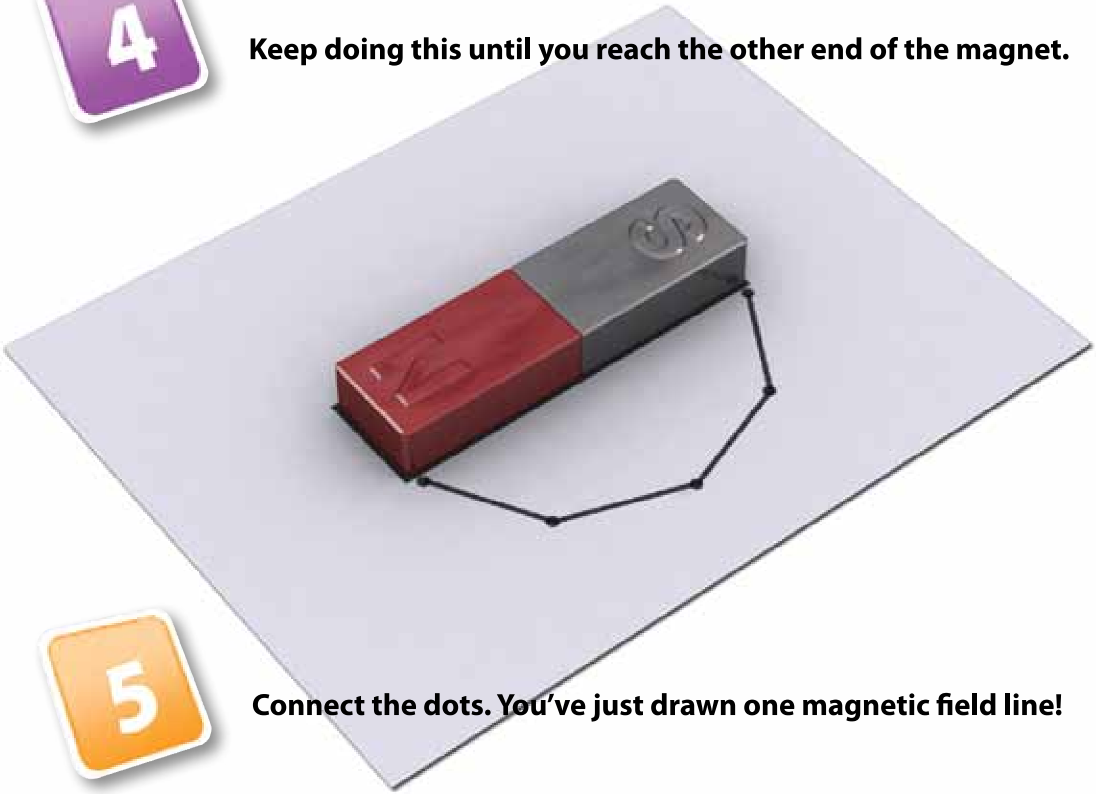
1. Place the bar magnet in the middle of the paper. Trace the outline of the magnet – that way you can put it back in the exact same spot if it gets bumped.

2. Place the compass at one pole of the magnet and make a dot next to it showing the direction the compass arrow points.

3. Move the compass so that the base of the arrow is at the dot you've just made. Now make a new mark where the tip of the arrow is pointing this time.



4 Keep doing this until you reach the other end of the magnet.



5 Connect the dots. You've just drawn one magnetic field line!

What you'll do next:

6. Go back and begin again, starting at a different spot than you did the first time. Repeat the above steps.
7. Repeat the process until you have drawn as many lines as you can for both ends of the magnet. You will now have an accurate representation of magnetic field lines.
8. Different magnets will give you different field lines. Try repeating these steps with magnets of different sizes and shapes.

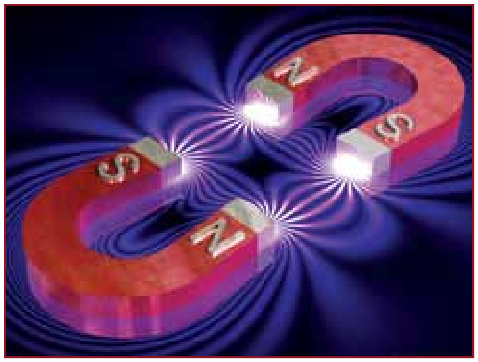
You can also "draw" field lines with iron filings, available at most hardware stores. Use the same magnet and paper (with your drawn field lines) from the above activity. Put the magnet back in place under the paper, then sprinkle the filings on top. Tap the paper gently; you should see the filings fall into place along the very same lines you drew. Preserve this discovery for posterity by spraying it with hairspray or acrylic spray! You can also try this as a "virtual" activity.

DID YOU KNOW?

- *Magnetic force decreases as the distance from the magnet increases.*
- *Magnetic force can travel through non-magnetic materials such as air and water.*
- *Compass needles point north and south in response to the Earth's magnetic field. You can also use them to detect magnetic fields of other objects.*

THINK QUICK

- *Where along your field lines is the magnetic force strongest?*



Answer: *The magnetic force is strongest near the poles, where the magnetic field lines come together.*

Can magnets control the weather?

FLUX STAFF REPORT

Some people say Tallahassee has gotten less rain since the Magnet Lab was dedicated in 1994. They claim they can see the rain going around the city on the weather radar — and have even called to ask us to turn off the magnets during particularly dry times.

People also say we are either responsible for steering hurricanes into the Gulf of Mexico, or away from the Gulf of Mexico, depending on the year.

So, you might be wondering: Can high magnetic fields affect the weather?

It's a very common question, often the first one our employees get asked when they say they work at the Magnet Lab. Our director has even been asked about it at the grocery store.

The Magnet Lab does create amazing high magnetic fields, some of the highest in the world. At the Tallahassee headquarters, we have a magnet that can reach 45 tesla. Tesla is the scientific unit of measurement of magnetic field strength. To put 45 tesla in perspective, a junkyard magnet — one that can pick up entire cars — is about 2 tesla.

What's important to remember is that — even though our magnetic fields are seriously strong — those fields are created in an extremely small space at the core of the magnet called the bore. (The bore is where samples are placed for experiments). Even the largest fields we create are present only in a few inches of space, inside a large, well-insulated metal container. Standing 10 feet away from one of these magnets won't even affect the magnetic strip on the credit card in your pocket, much less the weather patterns in the sky.

Is there a magnetic field outside the lab? There sure is, but it's the same as the rest of the planet. The area around the lab, including the airspace above it, doesn't have a substantially higher magnetic field than anywhere else. Even if it did, there's no evidence that a change in magnetic field would affect rainfall. So don't go asking us to turn on the magnets to redirect hurricanes away from the Panhandle (that has really happened!).

Maglev idea on track since the turn of the century — the 20th Century

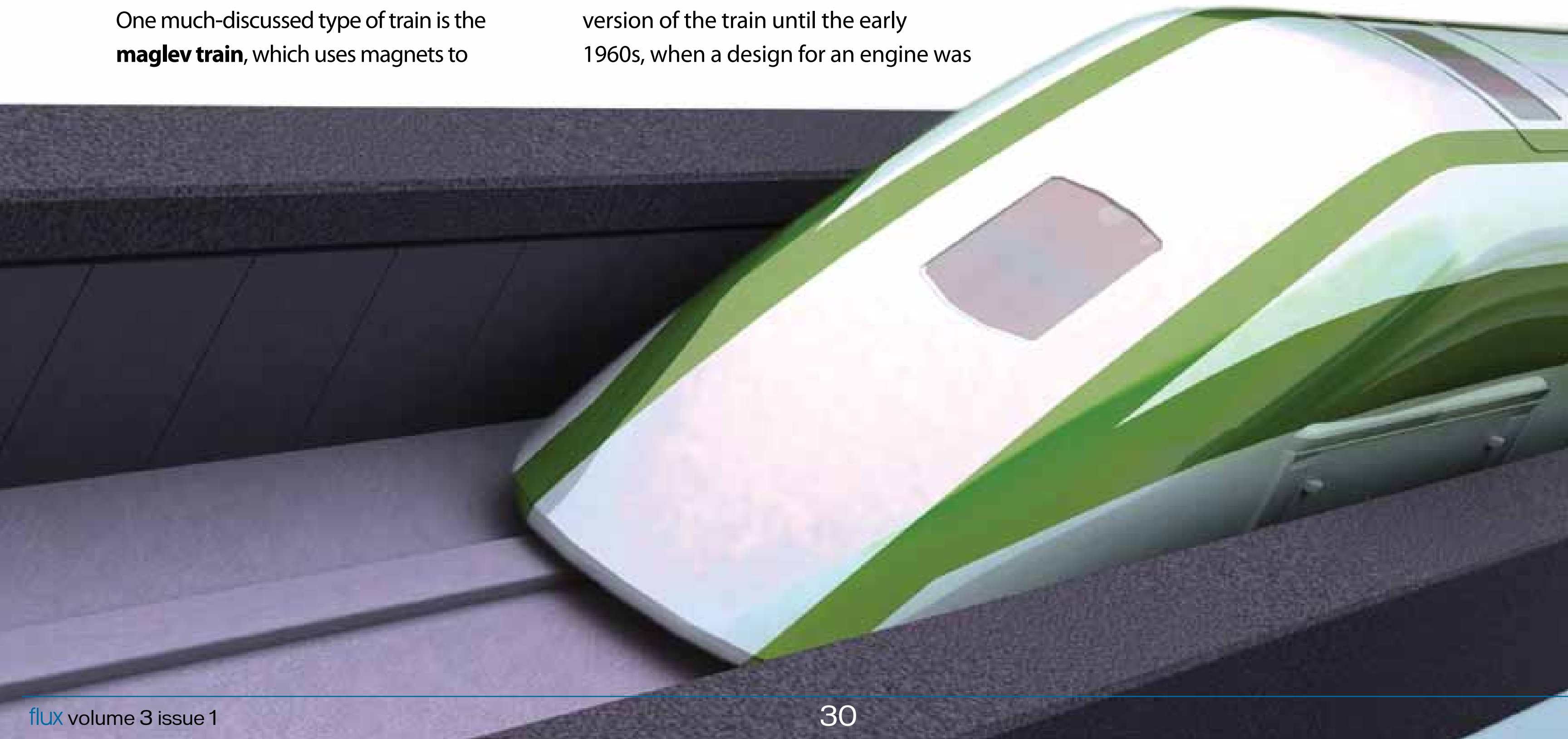
BY AMY MAST

Trains, once *the* way to move people and cargo long distances around the United States, are enjoying a comeback. This year alone, the U.S. government has promised $13 billion to fund various high-speed rail projects. Why? Trains are more energy-efficient than air travel, are safer than commuting in a car, and once they're up and running, trains are one of the cheapest forms of public transport around.

One much-discussed type of train is the **maglev train**, which uses magnets to glide on a cushion of air at amazingly high speeds—typically in the 150-250 mile per hour range. The cushion of air means far less friction and far more energy efficiency than traditional rail trains.

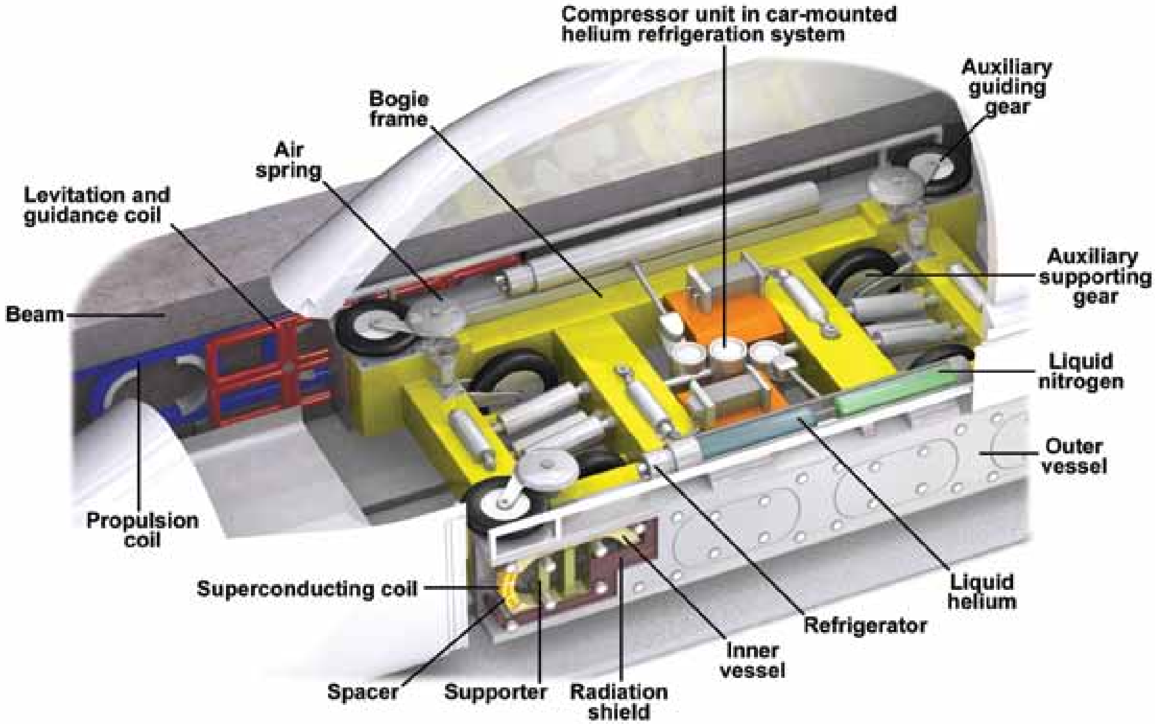
This might sound like something from a science fiction movie, but in fact, the first-ever patent for a variation on a high-speed train was granted in 1902. Similar patents followed in ensuing years, but engineers didn't hit on a truly workable version of the train until the early 1960s, when a design for an engine was developed that wouldn't require contact with the tracks. This type of engine is called a linear motor, and it's a concept that's still being fine-tuned today.

Maglev trains are powered in a number of ways, but as the name implies, all use some form of magnets — whether electromagnets or permanent magnets. Superconducting maglev trains are in the development stage. These trains



travel faster and are less expensive to operate in the long run because they employ superconductors, materials that conduct electricity without any friction, and therefore use very little electricity.

The biggest obstacle to Maglev development is cost. Since these superfast trains can't run on traditional tracks, they require the construction of all-new infrastructure from scratch—a daunting prospect in an uncertain global economy. That said, research on and proposals for new projects pop up as fast as other proposals are scrapped, primed for the time when the funding available matches the promise of this potentially game-changing technology.



DID YOU KNOW?

➤ The fastest high-speed train in the world is located in Shanghai. Though the entire track is only about 18 miles long, its top tested speed is 311 miles per hour. Train operators call the train's runs "flights."

‘Doing Science Together’ promotes everyday science connections

FLUX STAFF REPORTS

Basic science concepts can be difficult to illustrate at home. If you’re a parent or grandparent, your own science days may be years, even decades, behind you. **Doing Science Together**, a new initiative of the Center for Integrating Research & Learning (CIRL) at the National High Magnetic Field Laboratory, now offers small and large groups opportunities to learn inventive and simple ways to make connections between their everyday world and science.

This free program offers kids and adults of all ages a chance to learn about their world with hands-on activities that help participants:

- Make connections between science and their world
- Ask and answer questions
- Think scientifically
- Gain a sense of adventure and curiosity
- Learn simple science activities that can be done at home with basic materials

Programs are tailored to each group’s needs. Activities may feature listening walks, 10-minute field trips, or picture books to expand science vocabulary.

Doing Science Together is available to small and large groups including parents, senior citizens’ groups, student groups looking for science-fair strategies, science clubs, and adults who want to learn more about science. Workshops may be scheduled after school, evenings or on Saturdays and can take place at the Magnet Lab or off-site. For more information contact Carlos R. Villa at villa@magnet.fsu.edu or (850) 644-7191, or Pat Dixon at pdixon@magnet.fsu.edu or (850) 644-4707.

COMING UP

➤ Doing Science Together will be hosted by Barnes and Noble at 6:30 PM. at the Tallahassee mall on the following dates: January 21, February 18, March 18 and April 15.

Kids and adults alike get total access to scientists and their work at the Magnet Lab’s annual Open House.
Photo by Larry Gordon.

We're closing in on Open House!

Every February, the Magnet Lab invites the public to spend the day at its world-class research laboratory. Our 2009 Open House attracted a record 5,573 visitors — which suggests if you haven't yet been to an Open House, this is your year!

Our 2010 Open House is scheduled for Saturday, Feb. 27, 10 a.m. to 3 p.m. This free event features something for young and old alike: hands-on demonstrations, self-guided tours, activities from our Community Classroom Consortium partners and the chance to meet and chat with our scientists and other Mag Lab staff. It's also a chance to do good for the community: The canned goods we collect as the unofficial price of admission go to America's Second Harvest Food Bank of the Big Bend.

Open House offers an up-close look at the world-record 45-tesla hybrid magnet, the "900" - the strongest MRI scanner in the world - and other powerful research instruments.

A special Kids Zone, strategically located near the entrance, features science activities designed especially for young children.

With information and activities targeting a variety of ages, this event has become a popular family outing and is a unique opportunity to show children how fun – yes, fun! – science can be.

For more information on Open House, including and online examples of some of the demonstrations, visit www.magnet.fsu.edu/openhouse.

Magnets for lunch, anyone?

If you just can't wait until Open House to see the inside of the Mag Lab, you are in luck.

This summer, the lab launched standing public tours of the facility. These tours are held on the **third Wednesday of each month**. No reservations are required – just show up and check in at the reception desk by 11:30 a.m.

Once inside the Magnet Lab, visitors will understand what attracts hundreds of scientists from around the world to Tallahassee to conduct research using custom-made, multimillion-dollar magnets. The tours — which last about an hour — include a general overview of the lab and the research conducted, as well as explanations of the different types of magnets. Visitors don't even have to skip lunch to take the tour. Soup, sandwiches, salads and more are available at the Starbucks in the lab's atrium lobby.

What:
Public tours of the Magnet Lab

When:
The third Wednesday of each month

Time:
Tour starts promptly at 11:35 a.m. and lasts about an hour. Because of the size of the building and for other reasons, we cannot allow visitors to be unescorted in the building. Latecomers may not be able to catch up with tours once begun.

The monthly tours are intended for individuals and do not replace the group tours the lab has conducted since it opened its doors. The lab continues to offer prescheduled tours for groups of eight or more and special tours for student groups that include a hands-on learning activity. To arrange a group or school tour, call Felecia Hancock at (850) 645-0034. For more information about all the lab's tours, visit www.magnet.fsu.edu/tours.

Talks feature magnets, myths and mysteries

Want to learn what crude oil is really made of — and whether or "healing magnets" really work? Then be sure to mark your calendar to attend the lab's Magnet Mystery Hour series.

Magnet Mystery Hour is an ongoing series of talks that present the lab, its instruments and its research in a way that's accessible to non-scientists. The talks are presented by the scientists themselves — many of them leaders in their fields — in a conversational format appropriate for older students and adults. Each talk is held on a Tuesday night at 7 p.m., and is paired with a short tour of the facility at 6:30 p.m. A question and answer session follows each talk. Upcoming talks include:

- **Jan. 19, 2010, "Magnet Myths and Mysteries" —** If you like good anecdotes, you'll not want to miss this. Physicist Scott Hannahs offers a brief history of electricity and magnetism and discusses some of the most common myths about magnetism and the Magnet Lab. He'll take your questions, no matter how strange they might be.

- **March 23, 2010, "Magnets: From Mini to Mighty" —** There's a lot more to magnets than you think. This talk features a rundown of magnet types, uses and strengths, explained by Magnet Science and Technology Director Mark Bird in a way that will help make the facts stick.

See art in a science setting

The Magnet Lab's atrium serves as the main entrance for researchers and others visiting the lab, but several times a year, it transforms into Ars Magna, an art display space.

The goal of Ars Magna ("Great Art" in Latin) is to demystify science and make it more accessible to a different audience. The shows frequently feature artists affiliated with Florida State University or the scientific community, and attract people who wouldn't ordinarily think to visit the Magnet Lab. While here, visitors take in the lab's permanent art installation, Magnetic Moment, and have an opportunity to see the lab's big magnets.

All shows are held from 7 to 9 p.m. There is no admission charge. Visitors are welcome to see the art in the lobby during regular business hours (8 a.m. to 5 p.m.), but tours are not available for walk-in visitors.

For a schedule of upcoming shows, visit www.magnet.fsu.edu/arsmagna.

SciGirls turn knowledge into practice

This summer, more than 30 middle and high-school girls spent two weeks learning about the far reaching effects of water pollution and environmental degradation as part of SciGirls, a summer camp jointly organized by the Magnet Lab and WFSU-TV.

Armed with that knowledge, a growing sense of community activism and a grant from the Think About Personal Pollution (TAPP) program, SciGirls past and present gathered at the Magnet Lab on Saturday, Oct. 24 to plant a rain garden on Mag Lab grounds.

Rain gardens are a great way to help slow water runoff from buildings and roads. They act as filters to reduce the amount of pollutants seeping into our natural waterways. The rain garden at the Magnet Lab is located between the building and the natural pond at the back of the property.

Now in its fifth year offering the camps, the SciGirls team is working to extend the SciGirls experience to include additional activities that will bring all previous campers together to engage in meaningful community-based projects.

"This was just the first project of what we hope will be many more opportunities to help the girls remain connected with one another and participate in meaningful science related projects," said Kristen Molyneaux, a graduate research assistant and SciGirls teacher who is heading up the project. "We view these opportunities as an important component of the SciGirls experience."

For additional information on this project and other SciGirls activities, visit the SciGirls Tallahassee blog at: http://scigirls.blogspot.com/. For more information about rain gardens, visit http://www.tappwater.org/.

— Flux staff reports

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Magnet Promises to Revolutionize High Field Research

BY KRISTEN COYNE

The National High Magnetic Field Laboratory has been awarded nearly $3 million to build a novel kind of superconducting magnet that will break records for magnetic field strength, make possible new types of science and save vast amounts of energy and money.

The magnet, funded by a National Science Foundation grant of $2 million and a matching award from The Florida State University of $1 million, is projected to generate a magnetic field of 32 tesla. (Tesla is the scientific unit of measure of magnetic field strength.) That is more than 3,000 times stronger than a typical refrigerator magnet, and about 45 percent more powerful than the strongest superconducting magnets available today.

As impressive as that sounds, it is just the tip of the scientific iceberg. The material that will be used for this magnet, a type of high-temperature superconductor called yttrium barium copper oxide, or YBCO, promises to revolutionize research in high magnetic fields.

Superconducting magnets have been powering hospital MRI machines for decades (at about 1 to 3 tesla) and are commonly used in high-field research. They are valuable in part because they are made with special superconducting materials that conduct electricity without any friction, and therefore use very little electricity. Non-superconducting electromagnets, called resistive magnets, consume massive amounts of electricity. At the magnet lab, the average cost to run a resistive magnet is $774 per hour – 40 times more than a 20-tesla superconducting magnet.

One of the downsides to superconducting magnets is that the materials they are built with work only at temperatures so low that expensive cryogens, such as liquid helium, are needed to operate them. Also, traditional superconducting materials stop working inside a magnetic field above about 23 tesla, so resistive magnets have always been able to outperform them.

A YBCO coil is lowered into a cryostat for a test in July 2009 at the Mag Lab. Successful coil testing at high fields helped pave the way for the planned 32-tesla superconducting magnet.

But YBCO oversteps both these hurdles. It belongs to a class known as high-temperature superconductors. These materials perform at much higher temperatures than their "low-temperature" cousins, making them more practical and cheaper to operate – and they continue to operate beyond the point at which low-temperature superconductors cease working. Another huge benefit: Superconducting magnets create more stable magnetic fields than resistive magnets, which produce better data for scientists. All of this means the 32-tesla project will be the first of a whole new generation of powerful, low-cost superconducting magnets.

William Denis Markiewicz, principal investigator on the project, foresees the day when the lab's existing lineup of resistive magnets becomes obsolete.

"The objective is to develop and demonstrate the technology that can be used in magnets that will eventually replace the resistive magnets in our facility," said Markiewicz, a veteran engineer at the lab whose design achievements include the lab's world-record 900 megahertz, ultra-wide-bore superconducting magnet. "The advantages that will follow include lower operating costs and quieter field conditions for the scientist."

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